

MINISTRY OF LABOUR

DUST IN CARD ROOMS

FINAL REPORT OF THE JOINT ADVISORY
COMMITTEE OF THE COTTON INDUSTRY

LONDON

HER MAJESTY'S STATIONERY OFFICE

1961

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FOREWORD

The Joint Advisory Committee on Conditions of Work in the Cotton Trade was first appointed in November, 1944, to consider and advise on practicable methods of implementing certain provisions of the Factories Act, 1937, and other problems. In 1958 the Committee was reconstituted and its terms of reference re-defined.

Since 1946, four Interim Reports have been published which incorporate recommendations made by a Sub-Committee set up to study the problems of dust control in card rooms. In the First Report, published in 1946, the Committee suggested methods of improving dust control and in the Second Report, published in 1952, they reviewed at length the progress made along those lines. The Third Interim Report, published in 1957, gave an account of the development of the Shirley Pressure Point system of extracting dust from the main dust producing points on carding engines, and the Fourth Interim Report, published in 1960, described the Selrow device, another method of local exhaust ventilation.

The Final Report, which is now published, is in two parts: Part I summarises those recommendations in earlier published reports which are considered to be of continuing value: Part II describes the dust extraction device of Atmospheric Control Limited and gives the results of tests made of this device under laboratory conditions and under normal working conditions in a mill. It also describes an experiment carried out during the mill trials in which the extracted air was passed through filters and returned to the test enclosure.

MEMBERS OF THE JOINT ADVISORY COMMITTEE OF THE COTTON INDUSTRY

Miss A. S. Bettenson *H.M. Superintending Inspector of
Factories (Chairman)*

EMPLOYERS' REPRESENTATIVES

Mr. F. Dunkerley	}	<i>Nominees of the Federation of Master Cotton Spinners' Associa- tions Limited</i>
Mr. J. Lindley, O.B.E., J.P.		
Mr. G. B. Fielding, C.B.E.	}	<i>Nominees of the Cotton Spinners' and Manufacturers' Association</i>
Mr. J. M. H. Grey, T.D.		
Mr. J. Mills 		<i>Nominee of the Condenser and Allied Spinners' and Manu- facturers' Association</i>

TRADE UNION REPRESENTATIVES

Mr. H. Earnshaw, O.B.E., J.P.	}	<i>Nominees of the United Textile Factory Workers' Association</i>
Sir Alfred Roberts, C.B.E., M.A., J.P.		
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Mr. L. T. Wright		

INDEPENDENT MEMBER

Dr. D. W. Hill *Director of the British Cotton
Industry Research Association*

H.M. FACTORY INSPECTORATE REPRESENTATIVES

Mr. W. J. C. Plumbe 	<i>H.M. Superintending Inspector of Factories</i>
Miss E. K. Blackburn 	<i>H.M. District Inspector of Factories</i>
Mr. A. McAlpine 	<i>H.M. District Inspector of Factories</i>
Mr. K. Fletcher 	<i>H.M. Inspector of Factories (Secretary)</i>

MEMBERS OF THE DUST SUB-COMMITTEE

Miss A. S. Bettenson (<i>Chairman</i>)	Mr. R. H. Pearce, C.B.E.
Mr. W. Bowles	Sir Alfred Roberts, C.B.E., M.A., J.P.
Ald. H. Chorlton	Mr. E. Waller
Mr. C. Heaniker-Heaton	Mr. K. Fletcher (<i>Secretary</i>)
Dr. D. W. Hill	

To : T. W. McCullough, Esq., O.B.E.,
H.M. Chief Inspector of Factories.

Joint Advisory Committee of the Cotton Industry Final Report on Dust in Card Rooms

In our Fourth Interim Report submitted to you in October, 1959, we mentioned that we expected a further report from the Dust Sub-Committee when the mill trials of the dust extraction device submitted by Atmospheric Control Limited were completed. The Sub-Committee's report on these tests has now been made, and as this device is the last of those submitted for consideration, they ask that this be considered their Final Report on Dust in Card Rooms.

The Report is divided into two parts: Part I gives a summary of those recommendations of continuing value which were embodied in earlier published reports: Part II deals with the tests made on the device submitted by Atmospheric Control Limited.

In commending Part I to your notice we wish to draw particular attention to the section headed *Maintenance*. When appliances for controlling dust are installed the importance of satisfactory arrangements for maintenance cannot be over-emphasised; we think that systematic examinations of the kind suggested are the best method of ensuring the continued efficiency of the equipment.

In Part II the circumstances of the tests of the Atmospheric Control device are set out very fully and the results are given in detail. We support the conclusions on the device reached by our Sub-Committee, and share their reservations.

We have now reported on three different dust extracting devices: they vary in construction and in the amount of air withdrawn. We must re-emphasise the Sub-Committee's view, given under the heading *Local Exhaust Ventilation* in Part I of their Report, that careful consideration of all the circumstances will be necessary when deciding on the type of installation best suited for any particular card room.

During the mill trials of the Atmospheric Control Limited device the opportunity was offered to conduct an additional test in which the extracted air was passed through filters and returned to the test enclosure. The results are included in the Sub-Committee's report. They provide no reason for us to alter the view expressed in earlier reports that we have, as yet, no knowledge of a system of recirculating filtered air in card rooms which can be recommended to the industry.

The Dust Sub-Committee, under the title of Sub-Committee "B", was first appointed by the Joint Advisory Committee in 1944, and although the membership has changed during the intervening time several members have served during the entire 16 years of the Committee's life. When the Sub-Committee first met, the prospect of finding a solution to the old and intractable problem of card room dust cannot have seemed very bright. It is with particular pleasure, therefore, that we commend their Final Report on this subject to your notice and we agree that the means are now available to ensure the effective control of dust evolved during the carding process. We wish to thank all the members of the Sub-Committee for their sustained and devoted work, and also to support them in their appreciation of the efforts of all who have been concerned in the invention and testing of the devices which have been described in the reports.

Since we last reported to you one of our members, Mr. Charles Schofield, has retired and has been replaced by Mr. J. W. Whitworth. Mr. Schofield was a member of the Joint Advisory Committee from its inception in 1944 and we wish to place on record our appreciation of his valuable service. Mr. W. J. C. Plumbe, H.M. Superintending Inspector of Factories in the North West (Liverpool) Division, has taken the place of Mr. E. Waller who has been transferred to duties in another area.

(Signed) A. S. BETTENSON (*Chairman*)
ELIZABETH K. BLACKBURN
F. DUNKERLEY
HARRY EARNSHAW
GEO. B. FIELDING
J. M. H. GREY
DOUGLAS W. HILL
J. LINDLEY
A. MCALPINE
J. MILLS
W. J. C. PLUMBE
A. ROBERTS
JAMES W. WHITWORTH
LEWIS T. WRIGHT

K. FLETCHER (*Secretary*)

Joint Advisory Committee of the Cotton Industry

Dust Sub-Committee

Final Report on Dust in Card Rooms

Miss A. S. Bettenson,

Chairman of the Joint Advisory Committee.

Introduction

This Sub-Committee was appointed in 1944 to consider "practical methods of controlling and minimising the evolution of dust during the carding process and of the removal of such dust as is evolved as near as possible to the point of origin at the carding engine so as to prevent its entering the air of the work-room". Since that time we have issued four Reports, two of which have made specific recommendations about the use of exhaust ventilating devices for carding engines and have described both the devices and the tests to which they have been submitted. The tests of a third device, the last of those submitted for our examination, are described in detail in this Report.

We think that the means are now available to ensure the effective control of dust evolved during the carding process and to enable the industry to implement the provisions of Section 47 of the Factories Act, 1937. We consider that we have now discharged the original duty laid upon us and we should like this report to be considered as our Final Report on Dust in Card Rooms.

PART I

Review of Earlier Recommendations

At this point it is appropriate to review our earlier recommendations and to emphasise those which will assist in ensuring that the atmosphere of card rooms is kept as near as possible free from dust.

The earliest full-scale enquiry into the problem of dust in card rooms was made by a Departmental Committee appointed by the Home Secretary in 1927, which reported in 1931. Although this Committee concerned itself very largely with the medical aspects of the question, it also considered the practical problem of dust removal and came to the conclusion that the removal of process dust (as distinct from stripping dust) by the application of local exhaust ventilation was probably impossible. Its recommendations were aimed at preventing the evolution of dust in the card room by cleaning the cotton more efficiently in the earlier processes and by controlling more carefully the dust evolved in the stripping and cleaning of the cards.

VACUUM STRIPPING AND THE PNEUMATIC REMOVAL OF FLY

Some of these recommendations were repeated and expanded in our own First Interim Report and although the application of exhaust ventilation to the machine has now been shown to be practicable the importance of these other measures is in no way diminished. There is a clear distinction between the "process" dust which is continually generated during the ordinary carding of the cotton and the local dust clouds formed during the intermittent processes of grinding and cleaning the cards. The local exhaust appliances which we have described are designed to remove only the process dust and we wish to emphasise again that the use of vacuum stripping apparatus, the application of exhaust draught during brush stripping, and the use of pneumatic systems for the removal of card under-fly, are all of the greatest importance in maintaining a dust-free atmosphere in the card room.

DUST SUPPRESSION IN OPENING AND BLOWING ROOMS

In our previous reports we have stressed the importance of ensuring that as much dust as possible is extracted from the cotton during the pre-carding processes by better enclosure of the machinery and by the application of more efficient exhaust ventilation. In our First and Second Reports, specific recommendations were made about how this might be done. We think this control of dust in opening and blowing rooms should receive the most careful consideration in every mill according to its individual circumstances, not only because it will reduce the amount of dust sent forward to the cards and thereby assist in maintaining a dust free card room, but also because it will reduce the amount of dust to which the workers in the opening processes are exposed.

OILING OF COTTON

In our Second Interim Report, we considered also the effect of oiling the cotton. The results which had been obtained in some mills, where comparative dust estimations were made, were sufficiently encouraging for us to recommend oiling as an inexpensive method of reducing dust. The work on the application of exhaust ventilation to carding engines was then in its early stages. As exhaust devices have been developed and improved our tests have shown much higher efficiencies than could be obtained with oiling and we think that oiling alone can no longer be considered satisfactory as a method of dust control.

LOCAL EXHAUST VENTILATION

Our Third and Fourth Interim Reports both dealt primarily with the results of tests of particular card exhaust devices—the Third Report with the Shirley Pressure Point System and the Fourth with the Selrow device. A similar detailed account of the tests of the Atmospheric Control Limited device is contained in Appendices A and B, and is commented upon in Part II of this Report. The different devices vary not only in the methods by which they apply the exhaust draught and the positions at which they apply it but also in the amount of air they withdraw and comparison should not be based on percentage efficiencies alone. The physical circumstances of the tests are described in the Reports and it will be seen that there were inevitably a number of variable factors. The efficiencies which are given relate to the particular device in the particular set of circumstances and any variation in the construction of the device, in the volume of air extracted, in the type of cotton carded, or in the circumstances in which it is used, may obviously affect its performance. It is important, therefore, that careful consideration should be given to the type of device to be installed, having regard to the conditions in the mill in which it is to be fitted.

MAINTENANCE

The importance of good maintenance of exhaust equipment is to be kept at full efficiency has been mentioned in our Fourth Report and deserves further emphasis. If the devices we have examined are to perform satisfactorily year after year it is essential that they, and all the equipment associated with them, should be kept in first class condition and that the flow of air in the ducts should at all times be maintained at the recommended level. We do not think that this can be ensured unless maintenance is systematic and is carried out by persons specially qualified and appointed for the task. By this we do not mean to imply that routine tests need always be done by contracting firms of ventilating engineers, although we think that in many mills such an arrangement would be the most effective and convenient. It is essential, however, that the person carrying out the tests should be carefully instructed in the routine of

maintenance and testing and should keep sufficient records to be able to note any fall in the efficiency of the system.

We recommend that a thorough examination of the equipment should be made at least once in every six months and that a record of the examinations and tests should be kept. A suitable form of record is given in Appendix C.

If these recommendations are adopted it will be necessary to make provision in the ducting for the use of suitable instruments. This, we think, is a matter which should be taken up with the ventilating engineers who are engaged in installing the equipment and when such a firm of engineers is not itself under contract for the periodical maintenance of the equipment it should be asked to give sufficient information (perhaps by making the first entry in the Maintenance Register) to enable the management of the mill to keep the comparative records we have suggested above.

It is also essential that the workpeople in the card room should co-operate in ensuring proper maintenance of the devices. A local blockage in one of the ducts on a particular card can be noticed very quickly by the operative and he is often in a better position than anyone else to observe defects in the equipment on the engine itself. We think, therefore, that the persons employed in the card room should be asked not only to ensure, as far as possible, that the ducts are kept free from obstruction and in full working order but also to report to the management any defects in the exhaust equipment which may be noticed during ordinary working.

RECIRCULATION OF FILTERED AIR

The removal of large volumes of air from a card room by the use of exhaust ventilating equipment will obviously create problems about the maintenance of the correct temperature and humidity. The extracted air must either be filtered and recirculated or it must be replaced by fresh air which, at certain times of the year at least, will have to be warmed and sometimes humidified.

There may be certain advantages about recirculating the extracted air providing it can be done at a reasonable cost but it is necessary, in order to comply with Section 47 of the Factories Act, 1937, that the returned air should be free of dust. This is a very difficult thing to achieve. We considered the question in our Second Interim Report and gave the results of the tests and enquiries we had made. Our conclusion then was that although the required degree of filtration might be achieved with some types of equipment it was likely to be very expensive. Since that time the only test we have undertaken with recirculated air is that which is reported, together with the results of the mill trials of the Atmospheric Control Limited device, in Appendix B.

It will be seen from Part II of this Report, that it remains true that we have as yet no knowledge of an acceptable system of recirculating filtered air in card rooms.

When arrangements are made to extract these substantial volumes of air from a card room, therefore, means should be provided to replace it. It is not, generally speaking, satisfactory to allow replacement air to enter the card room from other parts of the mill, or to reach the cards by creating a draught across the entire card room. The placing of air inlets and the arrangements for warming and humidifying the incoming air should, we think, be considered at the same time as the installation of the exhaust hoods.

CONCLUSION

We are pleased to be able to say that since our Third Report many mills have installed exhaust ventilating devices on the carding engines. Where the

installation is complete the improvement in working conditions is very marked and we have also received reports of improvement in the well-being of operatives. We believe that with the full co-operation of all in the industry the dust problem in card rooms can be solved on the lines we have indicated in this Report.

In our work towards this end we have to acknowledge our indebtedness to a great many people. Not least among them are those who have devoted much time and money to the development of the ventilating appliances we have described, and who have worked over very long periods and through many disappointments to develop these devices. We have reason to be grateful also to the managements and staffs of the mills in which our tests were conducted, often to their great inconvenience, and to those who carried out the tests on our behalf.

We think a special mention is deserved of one member of your Sub-Committee, Mr. Samuel Sanderson, who served on the Departmental Committee on Dust in Card Rooms in 1927 and who has maintained throughout the years an unflagging interest in the subject. He has been a member of the Dust Sub-Committee since it was formed in 1944 and has thus provided a thread of continuity between the first full-scale enquiry into the problem of Dust in Card Rooms and what we hope will be its final solution. It is with the greatest regret, therefore, that we have to report that ill-health has prevented him from attending our recent meetings and also from signing this our Final Report.

PART II

Device made by Atmospheric Control Limited

The results of the tests of the Atmospheric Control Limited device are given in Appendices A and B. They were undertaken with the co-operation and participation of the manufacturers and consisted of a laboratory test on an isolated card followed by a trial under mill conditions using eleven cards in a specially built enclosure.

(1) Laboratory Test

The results of the tests on the isolated card were sufficiently encouraging for the Committee to undertake consideration of mill trials as soon as these could be arranged. No exact comparison can be made between the laboratory and mill tests; in the results of the laboratory tests an allowance is made for the dust which entered the test enclosure with the replacement air in order to calculate the theoretical efficiency of the device but, in the mill trial, no such allowance is made and the percentage efficiency is based on the actual reduction in the atmospheric dust load inside the test enclosure. Certain modifications to the design of the device had been made between the laboratory and the mill trials.

(2) Mill Trials

The mill trials themselves fall into three parts:

- (a) Dust estimations without the device fitted.
- (b) Dust estimations with the device fitted and the dust-laden air discharged outside the mill.
- (c) Dust estimations with the device fitted and the air filtered and recirculated through the plant supplied by Andrew Air Conditioning Limited.

CONCLUSIONS

(a) *Efficiency of the device with extracted air replaced by fresh air*

The overall efficiency of the device when the extracted air was replaced by fresh air will be seen from the results in Table V to be 67.5 per cent. judged on the reduction in the number of dust particles per cubic centimetre and from Table X to be 76 per cent. on the reduction of the mass of the dust regardless of its size.

It will be seen from Appendix B that the mill trials were subject to the influence of a number of variable factors, in particular:

- (1) The introduction of humidifying spray jets during Part Two of the trials.
- (2) The daily cleaning down system which was in use during the first part of the tests but not the second. No samples were taken while cleaning was being done, but the effect on subsequent samples cannot be known. This was allied with the practice during the first part of the tests of shutting down the plenum ventilation when samples were not being taken.
- (3) The position of the discharge openings in the plenum duct was altered between the first and later tests.
- (4) The trash content of the card room laps decreased slightly from 1.35 per cent. when no hoods were fitted to 1.15 per cent. with the hoods working. The details are given in Table XI.

Some of these variations resulted merely from changes in the works routine and all were beyond the control of those conducting the trials and it is difficult to assess their effect. It is to be noted that the cards used in the tests were metallic clothed and no vacuum stripping was necessary.

We think that, with due allowance for the variations, the tests show that the Atmospheric Control Device, used at the speed at which it was tested and with the dust discharged outside the mill, provides a method by which the provisions of Section 47 of the Factories Act, 1937, can be implemented in a card room. We have, however, some reservations in our recommendation of the device: it may not be practicable in all mills to exhaust air at the high speed used during the tests and where vacuum stripping is in use some modification of the hood over the doffer may be necessary.

(b) *Effects of Recirculation*

In the third mill test the air extracted from the cards was taken first through a separator to extract the coarse fly and then through a self-cleaning fabric filter with a total filtering area of 748 sq. ft. and a thread count of 104×68 . The results show that in those dust particle sizes which were being estimated by means of the thermal precipitator, the air contained more dust when the filtered air was returned to the room than when fresh air was introduced to replace that extracted by the device. The effect of recirculation under the conditions of the test was to alter the ratio between small and large particles. There was a marked reduction in the number of very fine particles but at 3.4 microns, for instance, the effect of recirculation was to double the concentration that existed when the extracted air was being discharged outside the mill. The ratio increased with the size up to the limits of accurate assessment at 4.8 microns. Two conditions differed as between this and the earlier parts of the trials:

- (a) The humidifying spray jets were stopped, and
- (b) the air extraction rate was reduced.

Here, again, the effects of the alterations in conditions cannot be accurately assessed.

This was an interesting experiment and we are grateful to the suppliers of the equipment for offering the facilities for the test but we do not think that the results provide us with evidence of an acceptable system of recirculating filtered air in card rooms.

(Signed) A. S. BETTENS ON (*Chairman*)
W. BOWLES
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C. HENNIKER-HEATON
D. W. HILL
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K. FLETCHER (*Secretary*)

APPENDIX A

Atmospheric Control Limited Device Laboratory Test Using an Isolated Card

On 2nd and 3rd October, 1958, tests of the device were made using a single card isolated in a polythene tent.

The card fitted with the Atmospheric Control device was a Platts 45-inch card which was employed on carding a strict low middling American cotton with a staple length of $\frac{3}{16}$ inch. The carding rate was 7 lbs. an hour. The card was installed in a room in the mill separate from the normal processes and was enclosed in a polythene tent having a cubic capacity of about 4,600 cubic feet. Air inlets were provided at the bottom of the tent consisting of slots approximately 9 inches $\times$ 3 inches on all sides. During the first day's tests air was withdrawn through the device at about 450 cubic feet per minute, thus giving roughly six changes of air per hour in the tent. On the second day the fan was stopped and the tent was unventilated except for such air as entered naturally through the inlets.

The card was run for approximately six hours on each day and was brush-stripped before and after the tests and once during the period. Samples were not taken while stripping was in progress.

Dust estimations were made by Mr. S. Smith, H.M. Chemical Inspector of Factories, using the thermal precipitator and instruments were placed near the taker-in, the doffer and the flats. A series of samples were taken at each position. Samples were also taken on each day in the air of the room outside the tent.

The results of the tests were as follows:

Table I
Atmospheric Control Limited Device
"Laboratory" Test using the Thermal Precipitator

<i>Contamination of the Air inside the Enclosure (Particles per c.c.)</i>			
<i>Sampling Position</i>	<i>Device Not Fitted</i>	<i>Device Fitted</i>	<i>% Reduction of dust</i>
Flats	533	309	42
Web	618	295	52
Taker-in	512	311	39
Average	554	305	45
Allowance for dust in the ambient atmosphere	26	298	
Nett Average	528	7	98.5

The figures in the table for contamination of the air inside the enclosure are averages of five samples taken at each position on each day. The figures for dust in the ambient atmosphere are averages of three samples taken on each day.

Mr. F. Brownsett of the British Cotton Industry Research Association concurrently took samples by electro-static precipitator for gravimetric measurement. The instruments were placed near the taker-in and the doffer. Tests were made for about six hours on each day and each measurement sampled about 10 cubic metres of air. The results were as follows:

Table II
Tests using the Electro-static Precipitator

<i>Position of Sampler</i>	<i>Mgms./cu.M.</i>		<i>% Efficiency</i>
	<i>Device Not Fitted</i>	<i>Device Fitted</i>	
Taken-in	2.94	0.70	76
Daffer	2.48	0.73	70
Overall	2.71	0.72	73

It is the opinion of Shirley Institute that with this technique of dust estimation a series of 5 six-hour tests is necessary to get a completely reliable result. The figures given above were obtained from 1 six-hour test in each condition.

In the calculation of the efficiency of the device in this table no allowance is made for the dust in the ambient atmosphere.

APPENDIX B

Mill Trials of the Atmospheric Control Ltd. Device

GENERAL CONDITIONS

For the purpose of the trials, part of the card room of a mill was partitioned off with hardboard and paper so as to form an enclosure of approximately 28,500 cubic feet containing a single row of eleven cards. The cards were evenly spaced on a floor area of 1,665 square feet. The lower part of the walls of the enclosure up to a height of about eight feet was made of hardboard on a wooden frame and above that the enclosure was completed to the roof members with brown paper. Four hinged doors were provided to allow for the handling of laps and cans. Air entered the enclosure through a 15-inch duct which ran the length of the enclosure at a height of about 13 feet above the floor, and the air was discharged from the duct through 24 holes of six inches diameter.

The eleven cards used in the trial were Platts 45-inch cards dated between 1905 and 1916. They were modified for individual drive and were employed in carding an El Paso cotton of a staple length of $1\frac{3}{8}$ inch at a rate of about 10 lbs. an hour. All the cards were metallic clothed. It was arranged that the weekly brush stripping of the cards and all other similar dust producing operations should be carried out at a time when no dust samples were being taken. The enclosure was cleaned before each part of the tests.

The trials were divided into three parts. In the first part, dust estimations were made in the enclosure with the cards running normally but without any special arrangement for the removal of the dust which was being evolved. In the second part, similar estimations were made but all the cards were fitted with the Atmospheric Control Ltd. Dust Extraction Device. During this test the extracted air was discharged outside the mill and was replaced by fresh air. In the third part, the same conditions applied except that the extracted air was filtered and recirculated inside the enclosure.

Two series of dust estimations were made concurrently in each part of the tests. Mr. F. Brownsett of the British Cotton Industry Research Association used electro-static precipitators over a period of five days in each part of the trials to obtain samples which were designed to be weighed to make an assessment of the gravimetric efficiency of the device. His instruments were placed at about the middle of the enclosure, one at the front and the other at the back of the cards. The other samples were taken by Mr. S. Smith, H.M. Chemical Inspector of Factories, using thermal precipitators. These were taken at the front and back of every individual card and in the spaces between the cards, and were designed to be counted to determine the efficiency of the device in the various dust particle size ranges.

Part I—Device Not Fitted

The first part of the trials took place between the 10th and 16th November, 1959. During this period fresh air was brought into the enclosure from outside the mill at a rate of about 1,600 cubic feet per minute, thus giving about $3\frac{1}{2}$ changes of air per hour. During this period it was the practice in the mill to stop the cards for approximately two hours between 12 noon and 2 p.m. to clear the under-fly and to blow down the cards by means of a jet of compressed air. No samples were taken while this was being done. It was also customary, because of the cold weather, to cut off the plenum ventilation when no sampling was in progress. Both these practices were discontinued in the later parts of the trials.

Part II—Device Fitted and Extracted Air Discharged Outside the Mill

The second part of the trials began on 1st December, 1959, but no valid results could be obtained and the tests were discontinued. The chief difficulty was that the webs of cotton from the card doffers tended to break and be sucked into the exhaust point over the doffer. As a result some of the cards were out of use for varying periods and the piecing-up of the webs caused heavy and abnormal clouds of dust. It was decided that the dust samples which had been taken could not be regarded as giving reliable evidence of the atmospheric conditions in the enclosure.

The second part of the trials began again on 11th January, 1960. The device as it was then fitted to each card consisted of three slotted ducts of circular section, arranged over the lick-in near the flats brush and over the doffer. Air was withdrawn through the ducts, which were connected to trunking installed beneath the floor of the enclosure, and was discharged through a separator to open air. A cover was provided over the space between the doffer cover and the calender rollers, thus giving an enclosure for the doffer extraction point. The design of this point had been altered since the discontinued tests and the original duct of triangular section with a single slot across the width of the card had been replaced by a circular duct with six graduated slots. The position of the duct had also been altered so as to withdraw the extraction opening from a point near the doffer comb to a point six or seven inches from the face of the doffer cylinder. The new circular duct was also provided with an aperture in its underside to apply exhaust ventilation near the calender rollers. This aperture could be opened or closed by means of a sleeve on the duct and was designed to be closed while the web was being pieced up and open at other times.

The fresh air supplied to the enclosure through the plenum ventilating system in this part of the trial was increased to between 7,000 and 7,500 cubic feet per minute so as to balance the air extracted by the Atmospheric Control Ltd. Device. There were thus between $14\frac{1}{2}$ and $15\frac{1}{2}$ changes of air per hour in the enclosure. The volume of air extracted through the exhaust ventilating system was between 5,000 and 6,000 cubic feet per minute or on average about 500 cubic feet per minute per card. A slight positive pressure was therefore maintained in the enclosure throughout this part of the trial.

Immediately before this part of the trial began, an attempt had been made to obtain the required humidity by humidifying the air entering the enclosure through the plenum ventilating system. In the weather conditions prevailing and because of the volume of air being handled this had been found to be inefficient and humidifying apparatus had therefore been installed in the enclosure itself. The apparatus was in use throughout this part of the tests, and consisted of six jets of compressed air and water arranged in pairs along one wall of the enclosure at a height of about ten feet. The compressed air was supplied to the apparatus at a pressure of about 80 lbs. to the square inch. On 11th January, when this part of the trial began, the jets were so placed that the spray was directed horizontally across the enclosure, but on 13th January the position of the jets was altered so that they pointed obliquely upwards. It was explained that this had been done because of the danger of the spray affecting the metalwork of the cards.

The discharge openings of the plenum duct were also altered in this part of the tests. During the first part of the trials they had pointed obliquely downwards, but they were altered during the abandoned tests at the beginning of December so as to direct the air obliquely upwards, and they remained in this

position during the whole of the remainder of the trials. It was explained that this was done because the turbulence created by the draught from the plenum trunking was affecting the webs.

Part III—Device Fitted and Extracted Air Filtered and Recirculated

The third part of the trials took place between the 18th and 22nd January, 1960. The general conditions of the trial were the same as those reported in the second part, except that :

- (1) The air extracted from the cards was passed through a separator to extract the fly and was then filtered through a fabric filter before being returned to the enclosure through the plenum ducting previously described. The filter employed was a No. 6 type "C" Dynadone supplied and installed by Andrew Air Conditioning Limited. The unit was fitted with 34 flat filter bags, each having a net cloth filtering area of 22 square feet, thus giving a total area of 748 square feet. The type of material used for the filter bags was cotton sateen, having a thread count of 104×68 .
- (2) The air extraction rate from each card was reduced in this part of the tests to between 360 and 400 cubic feet per minute. The reduction in air flow was presumed to be due to the increased resistance in the system caused by the introduction of the filter and additional ducting for the return of the filtered air.
- (3) The spray jets introduced in the second part of the tests for the purpose of maintaining humidity were no longer in use.

The results of the dust estimations made during all three parts of the tests are given in the attached tables.

Table I
ATMOSPHERIC CONTROL LIMITED DEVICE
Device Not Fitted

Sample No.	Notes	Particles per c.c.	Particles per c.c. in size range of given upper limit (Microns)							
			0.6 & below	1.2	2.4	3.4	4.8	6.7	9.5	Over 9.5
1		946	671	156	67.6	20.8	11.8	7.10	11.4	—
2		1,220	771	268	68.3	44.0	24.8	14.6	14.9	13.9
3		1,290	774	331	80.9	55.6	21.5	4.90	11.7	11.1
4		1,340	895	258	89.5	59.2	19.2	6.30	6.03	5.76
5		1,010	684	199	72.7	33.9	9.70	7.27	4.04	—
6		1,530	909	364	135	57.8	25.7	12.9	6.43	19.3
7		1,030	629	245	92.8	34.5	10.6	8.96	5.25	6.90
8		1,150	835	205	68.3	15.2	14.7	6.21	5.75	—
9		1,030	631	249	100	28.0	10.5	5.15	3.71	3.09
10		1,010	573	300	65.4	22.8	17.4	13.6	14.6	3.64
11		1,130	642	293	135	47.8	6.89	3.96	3.05	—
12		1,030	651	235	94.7	26.1	14.2	2.47	5.15	1.55
13		1,140	705	318	51.3	35.0	16.9	7.75	3.08	2.74
14	Long fibres present unduly in B. sample	800	368	259	82.1	34.6	17.3	4.80	16.8	17.3
15		980	461	274	151	48.0	20.6	9.60	13.7	4.12
16	A. slide blocked B. slide broken	—	—	—	—	—	—	—	—	—
17		1,630	783	524	164	93.9	31.3	15.6	15.6	2.12
18		1,340	617	452	123	94.6	21.4	20.0	12.1	—
19		1,490	828	467	135	34.0	13.7	2.68	3.43	6.11
20		1,800	887	460	268	109	41.9	25.2	8.46	—
21		824	541	177	65.7	25.3	10.1	5.03	—	—
22		994	615	198	110	43.9	22.0	5.47	—	—
23		1,440	830	244	187	89.4	48.8	24.3	16.3	—
24		953	554	229	110	41.3	13.7	4.57	—	—
25		1,350	849	349	110	41.1	20.6	13.8	6.81	—
26		1,280	694	334	143	54.5	27.3	20.5	6.78	—
27		986	717	198	55.9	15.3	—	—	—	—
28		997	748	163	48.0	19.1	14.4	4.79	—	—
29		787	603	120	48.7	11.3	3.78	—	—	—
30		1,010	705	210	52.4	19.1	9.49	4.75	—	—
31		1,350	966	260	75.3	27.4	13.8	6.89	—	—
32		1,080	767	225	53.8	24.4	9.72	—	—	—
33		740	507	187	36.1	9.32	0.81	—	—	—
AVERAGES		1,150	700	273	98.1	41.1	16.4	8.42	6.10	3.05

Table II
ATMOSPHERIC CONTROL LIMITED DEVICE
Device Fitted and Discharging Extracted Air Outside the Mill

Sample No.	Notes	Particles per c.c.	Particles per c.c. in size range of given upper limit (Microns)							
			0.6 & below	1.2	2.4	3.4	4.8	6.7	9.5	Over 9.5
1		643	213	272	87.8	31.5	22.2	6.49	7.07	3.22
2		864	537	208	69.4	13.9	13.9	6.91	10.37	3.89
3		433	231	148	29.3	8.14	1.65	3.25	4.89	6.50
4		207	113	70.1	9.79	4.55	1.86	2.88	2.07	3.19
5		186	144	33.6	6.34	1.82	—	—	—	—
6		90	71.6	12.9	4.97	0.50	—	—	—	—
7		130	104	20.4	4.38	0.73	—	—	—	—
8		234	158	54.1	17.6	3.53	1.17	—	—	—
9		420	291	89.5	22.9	11.5	4.58	—	—	—
10		322	265	40.5	9.53	4.77	2.38	—	—	—
11		296	234	46.9	10.7	2.66	1.33	—	—	—
12	A. sample only	226	179	26.2	13.1	5.83	1.47	—	—	—
13		430	319	73.3	28.7	9.55	—	—	—	—
14		346	282	49.7	11.2	3.22	—	—	—	—
15		284	243	32.2	9.20	—	—	—	—	—
16		338	300	27.0	7.20	3.58	—	—	—	—
17	A. sample only	288	241	28.8	13.3	4.44	—	—	—	—
18		342	284	38.0	12.7	7.59	—	—	—	—
19		540	441	55.6	23.8	11.9	7.94	—	—	—
20		530	422	65.2	31.2	11.3	—	—	—	—
21		334	287	30.4	13.5	3.37	—	—	—	—
22		520	426	56.2	28.1	9.36	—	—	—	—
23		654	523	85.7	31.6	13.5	—	—	—	—
24		630	486	331	8.88	2.21	—	—	—	—
25	A. sample only	360	299	44.2	10.7	4.57	1.51	—	—	—
26		380	335	39.0	4.67	1.56	—	—	—	—
27		300	226	56.9	11.4	4.26	1.41	—	—	—
28		348	294	39.0	10.5	2.99	1.50	—	—	—
29		262	217	34.3	7.36	2.46	1.23	—	—	—
30		476	400	59.6	8.23	6.19	2.05	—	—	—
31		480	403	58.6	13.2	3.79	1.87	—	—	—
32		240	177	46.0	11.2	4.18	1.39	—	—	—
33	A. sample only	194	139	39.5	11.8	2.52	1.69	—	—	—
AVERAGES		374	282	64.1	18.0	6.12	2.16	0.59	0.73	0.51

Table III

ATMOSPHERIC CONTROL LIMITED DEVICE

Device Fitted and Extracted Air being Filtered and Recirculated

Sample No.	Notes	Particles per c.c.	Particles per c.c. in size range of given upper limit (Microns)							
			0.6 & below	1.2	2.4	3.4	4.8	6.7	9.5	Over 9.5
1		179	90.0	50.4	19.8	8.06	4.82	1.79	2.17	1.97
2		174	74.1	54.5	21.2	9.07	3.95	4.33	5.43	3.13
3		184	63.5	57.0	35.0	15.0	7.01	2.45	2.96	0.72
4		173	61.7	56.0	28.4	12.2	5.69	4.07	3.25	1.73
5		169	39.0	45.5	42.3	16.3	9.75	8.13	4.87	3.24
6		239	76.4	60.1	60.1	16.3	9.75	4.88	4.88	6.50
7		125	45.0	28.6	26.2	12.3	4.90	3.28	2.45	2.45
8		192	56.1	74.0	33.4	13.0	7.33	4.07	0.81	3.26
9		126	24.5	50.7	26.2	11.5	3.28	1.64	4.91	3.28
10		121	31.0	36.8	28.6	11.4	5.72	2.46	3.27	1.63
11		88	17.1	31.8	24.4	4.88	4.88	3.18	1.20	0.54
12		186	34.3	44.0	53.8	24.5	22.0	4.89	0.89	2.46
13		210	52.1	68.4	47.2	14.7	11.4	8.15	3.26	4.89
14		200	52.1	63.4	45.5	16.3	6.50	6.50	3.26	6.50
15		132	35.9	34.2	32.6	11.4	3.26	3.26	4.88	6.52
16		288	87.9	92.7	58.6	24.4	9.76	5.01	4.81	4.78
17		189	58.7	45.6	42.4	14.7	9.77	6.52	4.90	6.52
18		205	55.3	109	19.5	4.88	6.50	3.26	4.88	1.62
19		87	21.3	26.3	21.3	4.94	3.30	4.91	3.26	1.64
20		187	45.5	48.8	52.1	19.5	8.13	6.51	3.29	3.22
21		311	114	94.4	43.9	27.7	13.0	4.94	4.82	8.15
22	Spoilt for sizing	126	—	—	—	—	—	—	—	—
23		118	65.5	36.9	10.2	3.40	1.45	0.48	—	—
24		98	57.1	28.8	7.86	2.62	1.05	0.52	—	—
25	Insufficient for sizing	40	—	—	—	—	—	—	—	—
26		122	71.1	34.3	9.81	3.06	1.84	1.23	0.61	—
27	Insufficient for sizing	88	—	—	—	—	—	—	—	—
28		144	76.4	40.2	15.3	5.63	3.21	1.61	0.81	0.81
29		84	32.7	19.9	11.4	9.61	3.91	3.20	1.78	1.42
30	Spoilt for sizing	186	—	—	—	—	—	—	—	—
31	Insufficient for sizing	116	—	—	—	—	—	—	—	—
32		176	67.4	38.6	26.9	15.3	15.3	6.28	3.59	2.69
33	Insufficient for sizing	94	—	—	—	—	—	—	—	—
AVERAGES		*156	†55.8	50.8	31.3	12.3	6.94	3.98	3.01	2.95

* This figure is an average of 33 samples.

† These figures are an average of 27 samples.

Table IV
ATMOSPHERIC CONTROL LIMITED DEVICE
Summary of Results

<i>Particles per c.c. in size ranges of given upper limit (Microns)</i>									
	0.6	1.2	2.4	3.4	4.8	6.7	9.5	Above 9.5	TOTAL
Device not fitted	700	273	98.1	41.1	16.4	8.42	6.1	3.05	1,150
Device fitted (air discharged)	282	64.1	18	6.12	2.16	0.59	0.73	0.51	374
Device fitted (air recirculated)	55.8	50.8	31.3	12.3	6.94	3.98	3.01	2.95	156*

* This figure is an average of 33 samples. The size figures are averages of 27 samples. Please see Table III.

Table V
ATMOSPHERIC CONTROL LIMITED DEVICE
Efficiency of the Device when the Extracted Air was Discharged Outside the Mill

<i>Particles per c.c. in size ranges of given upper limit (Microns)</i>									
	0.6	1.2	2.4	3.4	4.8	6.7	9.5	Above 9.5	OVERALL
Device not fitted	700	273	98.1	41.1	16.4	8.42	6.10	3.05	1,150
Device fitted	282	64.1	18.0	6.12	2.16	0.59	0.73	0.51	374
EFFICIENCY %	59.7	76.5	81.7	85.11	86.8	93*	88*	83.3*	67.5

* These figures are less reliable than the other values for per cent. efficiency.

Table VI
ATMOSPHERIC CONTROL LIMITED DEVICE
Effect of Recirculation
Ratio of Particles per c.c. with Recirculated Air to Particles per c.c. without Recirculated Air.

<i>Upper limit of size range (Microns)</i>								
0.6	1.2	2.4	3.4	4.8	6.7	9.5	Over 9.5	OVERALL
0.20	0.79	1.74	2.01	3.21	6.75*	4.12*	5.78*	0.42 to 0.45

* These figures are less reliable than the others in this table.

Comment

From these figures it appears that in, for example, the 3.4 microns size range, the effect of recirculating the filtered air was to double the dust concentration which existed when the extracted air was discharged outside the mill. The ratio increases linearly with the size up to the limits of accurate assessment (i.e. 4.8 microns).

Table VII
ATMOSPHERIC CONTROL LIMITED DEVICE
Gravimetric Tests Without Hoods Fitted

<i>Date</i>	<i>Sampler No.</i>	<i>Position of Sampler</i>	<i>Atmospheric dust load (mgm./cu. M.)</i>	<i>Mean for position</i>	<i>Daily mean</i>
10.11.59	C1	Taker-in end	2.68	2.94	3.25
	C2		3.20		
	D1	Doffer end	3.36	3.55	
	D2		3.74		
11.11.59	C1	Taker-in end	2.15	2.58	3.19
	C2		3.00		
	D1	Doffer end	3.68	3.81	
	D2		3.94		
12.11.59	C1	Taker-in end	2.46	2.51	2.85
	C2		2.56		
	D1	Doffer end	2.97	3.18	
	D2		3.38		
13.11.59	C1	Taker-in end	2.24	2.57	2.97
	C2		2.89		
	D1	Doffer end	3.69	3.37	
	D2		3.04		
16.11.59	C1	Taker-in end	2.89	3.00	3.27
	C2		3.10		
	D1	Doffer end	3.25	3.55	
	D2		3.85		

Mean C1 C2 = 2.72

Mean D1 D2 = 3.49

Overall mean = 3.10

Table VIII
ATMOSPHERIC CONTROL LIMITED DEVICE
Gravimetric Tests With Hoods Fitted
(Fresh air replacing exhausted air)

<i>Date</i>	<i>Sampler No.</i>	<i>Position of Sampler</i>	<i>Atmospheric dust load (mgm./cu.M.)</i>	<i>Mean for position</i>	<i>Daily mean</i>
11.1.60	C1	Taker-in end	0.60	0.57	0.51
	C2	Taker-in end	0.54		
	D1	Doffer end	0.46	0.45	
	D2	Doffer end	0.43		
12.1.60	C1	Taker-in end	0.93	1.01	0.95
	C2	Taker-in end	1.08		
	D1	Doffer end	0.94	0.89	
	D2	Doffer end	0.84		
13.1.60	C1	Taker-in end	1.08	1.07	0.85
	C2	Taker-in end	1.05		
	D1	Doffer end	0.63	0.64	
	D2	Doffer end	0.65		
14.1.60	C1	Taker-in end	0.87	0.80	0.63
	C2	Taker-in end	0.72		
	D1	Doffer end	0.47	0.47	
	D2	Doffer end	0.47		
15.1.60	C1	Taker-in end	1.07	1.11	0.81
	C2	Taker-in end	1.14		
	D1	Doffer end	0.54	0.52	
	D2	Doffer end	0.49		

Mean C1 C2 = 0.91

Mean D1 D2 = 0.59

Overall mean = 0.75

Table IX
ATMOSPHERIC CONTROL LIMITED DEVICE
Gravimetric Tests With Hoods Fitted
(Air recirculated)

Date	Sampler No.	Position of Sampler	Atmospheric dust load (mgm./cu.M.)	Mean for position	Daily mean
18.1.60	C1	Taker-in end	0.76	0.71	0.74
	C2	Taker-in end	0.66		
	D1	Doffer end	0.85	0.77	
	D2	Doffer end	0.69		
19.1.60	C1	Taker-in end	0.68	0.68	0.63
	C2	Taker-in end	0.68		
	D1	Doffer end	0.58	0.57	
	D2	Doffer end	0.56		
20.1.60	C1	Taker-in end	0.69	0.71	0.66
	C2	Taker-in end	0.73		
	D1	Doffer end	0.59	0.62	
	D2	Doffer end	0.64		
21.1.60	C1	Taker-in end	0.74	0.72	0.71
	C2	Taker-in end	0.69		
	D1	Doffer end	0.72	0.70	
	D2	Doffer end	0.68		
22.1.60	C1	Taker-in end	0.64	0.70	0.64
	C2	Taker-in end	0.76		
	D1	Doffer end	0.58	0.57	
	D2	Doffer end	0.56		

Mean C1 C2 = 0.70

Overall mean = 0.67

Mean D1 D2 = 0.65

Table X
ATMOSPHERIC CONTROL LIMITED DEVICE
Hood Efficiency by Gravimetric Tests

- (a) Fresh air admitted: overall mean = 76 %
 taker-in end = 67 %
 doffer end = 83 %
- (b) Recirculated air: overall mean = 78 %
 taker-in end = 74 %
 doffer end = 81 %

Table XI
Shirley Analyser Tests

Shirley Analyser tests were made on the laps being carded to find the amount of trash in the cotton. The results were as follows:

		Trash Content
November 10th-16th	No hoods	1.35 %
January 11th-22nd	Hoods fitted	1.15 %



Fig. I

General view of the device showing the three extraction points. The exhaust trunking to which the device is connected is beneath the floor.



Fig. II

The extraction point over the doffer showing the metal cover and transparent flap.



Fig. III
The extraction point over the lick-in.



Fig. IV
Transparent flap raised for gating-up.

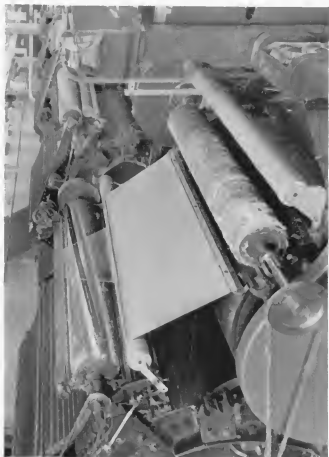


Fig. V
The cover raised for brush stripping of the doffer.

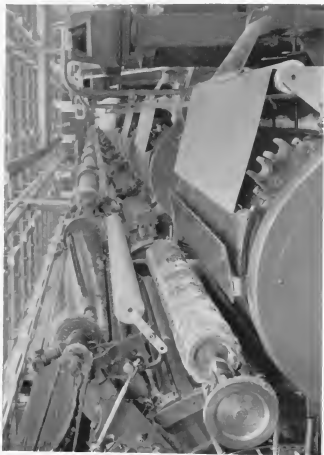


Fig. VI
Brush stripping of the cylinder with the device in position.